

B Production in Multijet Events: Data and Pythia, Herwig Simulations

A. Annovi P. Giannetti

Alberto Annovi
alberto.annovi@pi.infn.it

**Matrix Element/Monte Carlo
Tuning Workshop**
Fermilab, October 4, 2002

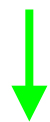
QCD Multijet background with b-quarks inside: is it well reproduced by Herwig & Pythia?

- Important background for a light Higgs ($< 140 \text{ GeV}$) in hadronic events
- Pythia problems in the CDF Run I experience
- Compare Pythia with Herwig: is a Pythia or a shower-montecarlo problem?
- Test independently different b production mechanisms

SM Higgs Xsec @ Fermilab Tevatron

For Higgs mass $< 140 \text{ GeV}$,
 $H \Rightarrow b\bar{b}$ is important
 $HV \Rightarrow b\bar{b}q\bar{q}$ is known @ CDF
 what about $Hq\bar{q}$?

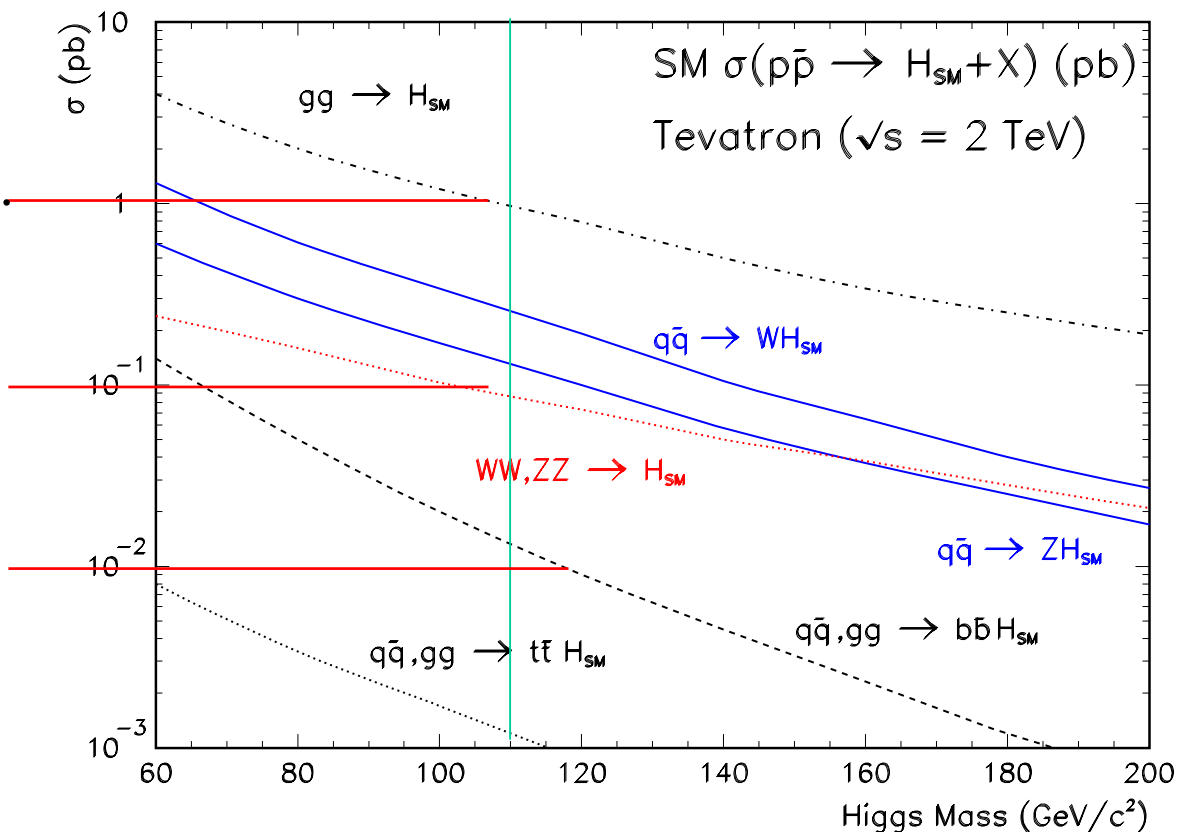
With 2 fb^{-1}



2000 eve.

200 eve.

20 eve.



Pythia vs CDF

H/A $bb \Rightarrow bbbb$

Fermilab-Conf-99/164-E

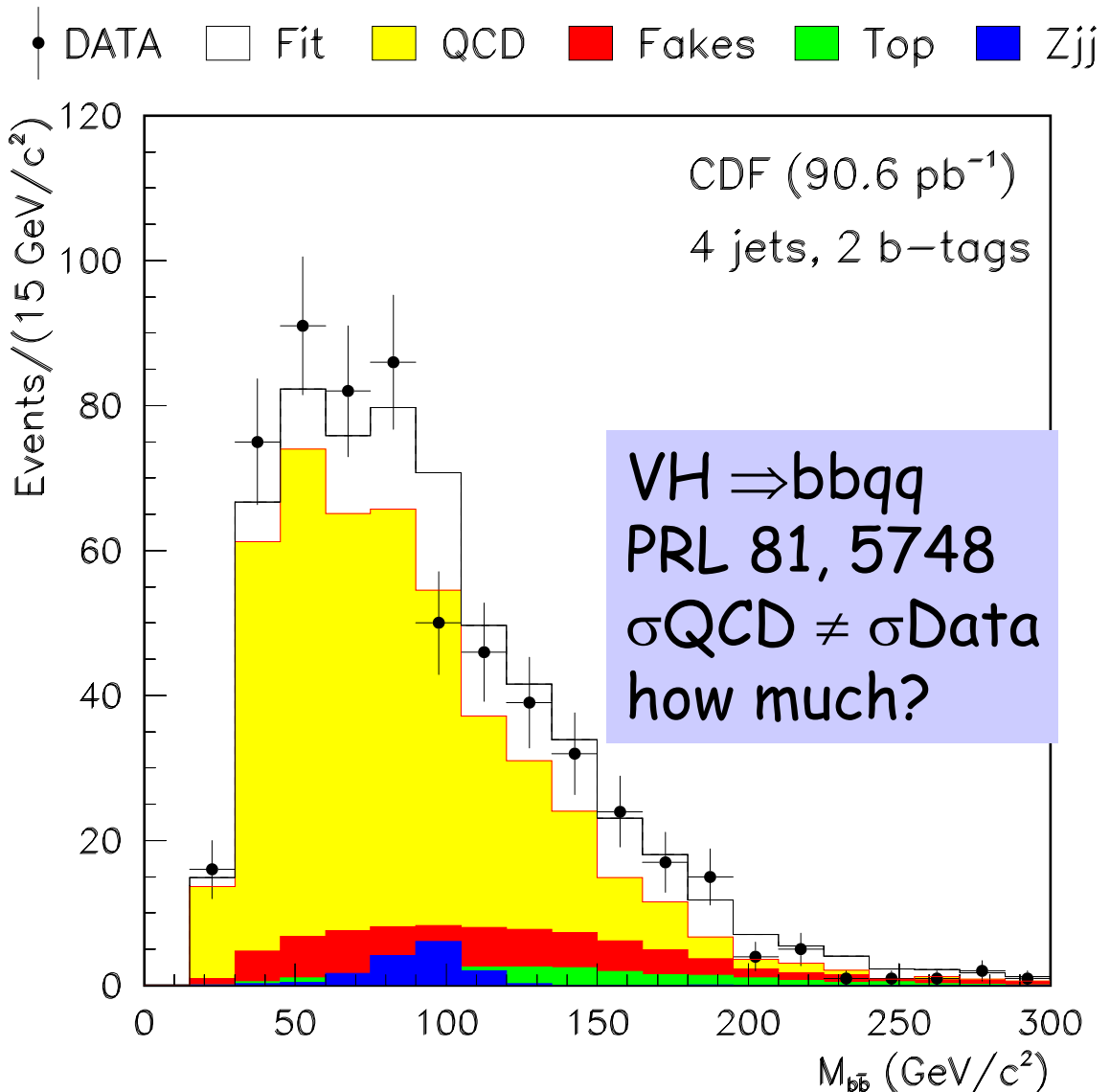
1 fb⁻¹

CDF run I

50.6 ± 11.0

PYTHIA

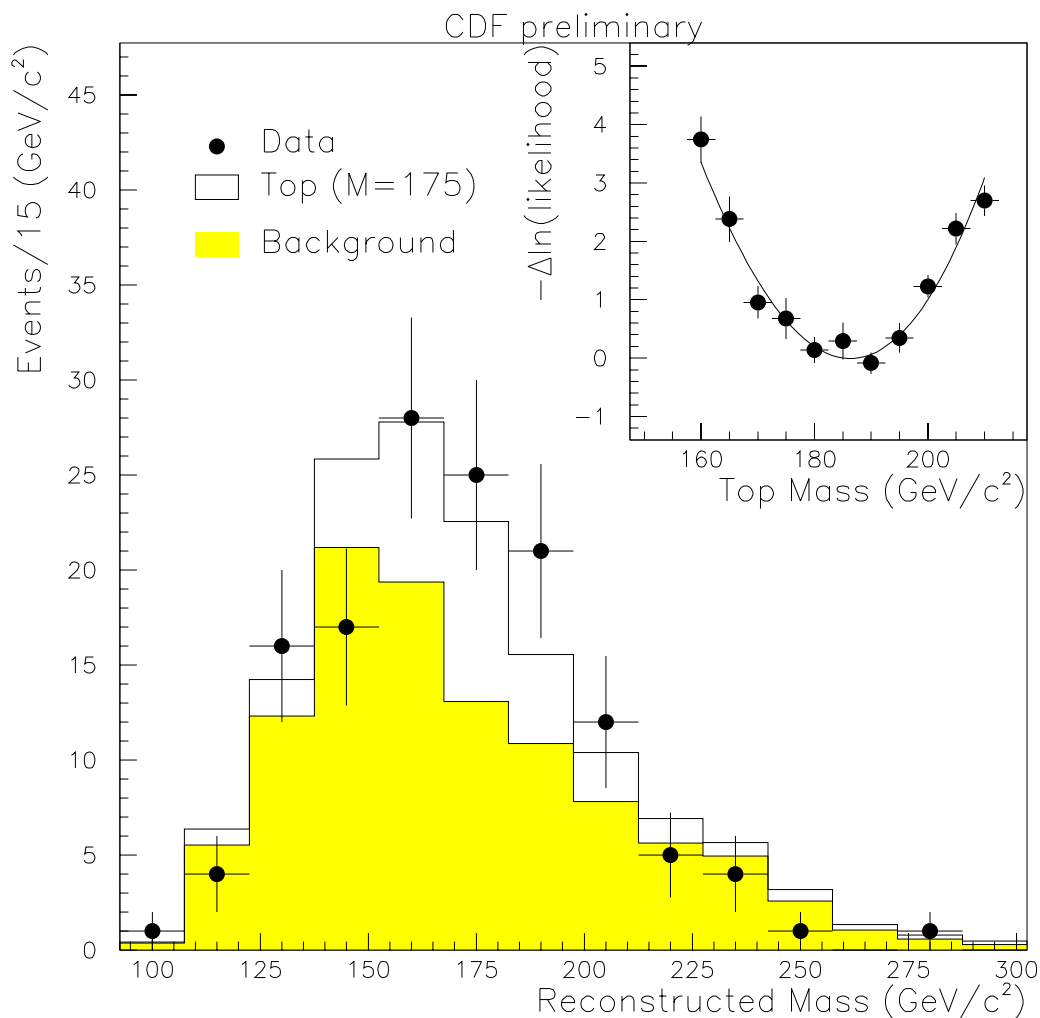
1856.2 ± 703.5



All-hadronic decay of top quark

PRL 79, 1992

$\sigma_{\text{QCD}} \neq \sigma_{\text{Data}}$
how much?



To summarize

Multijet QCD background

Pythia vs CDF data

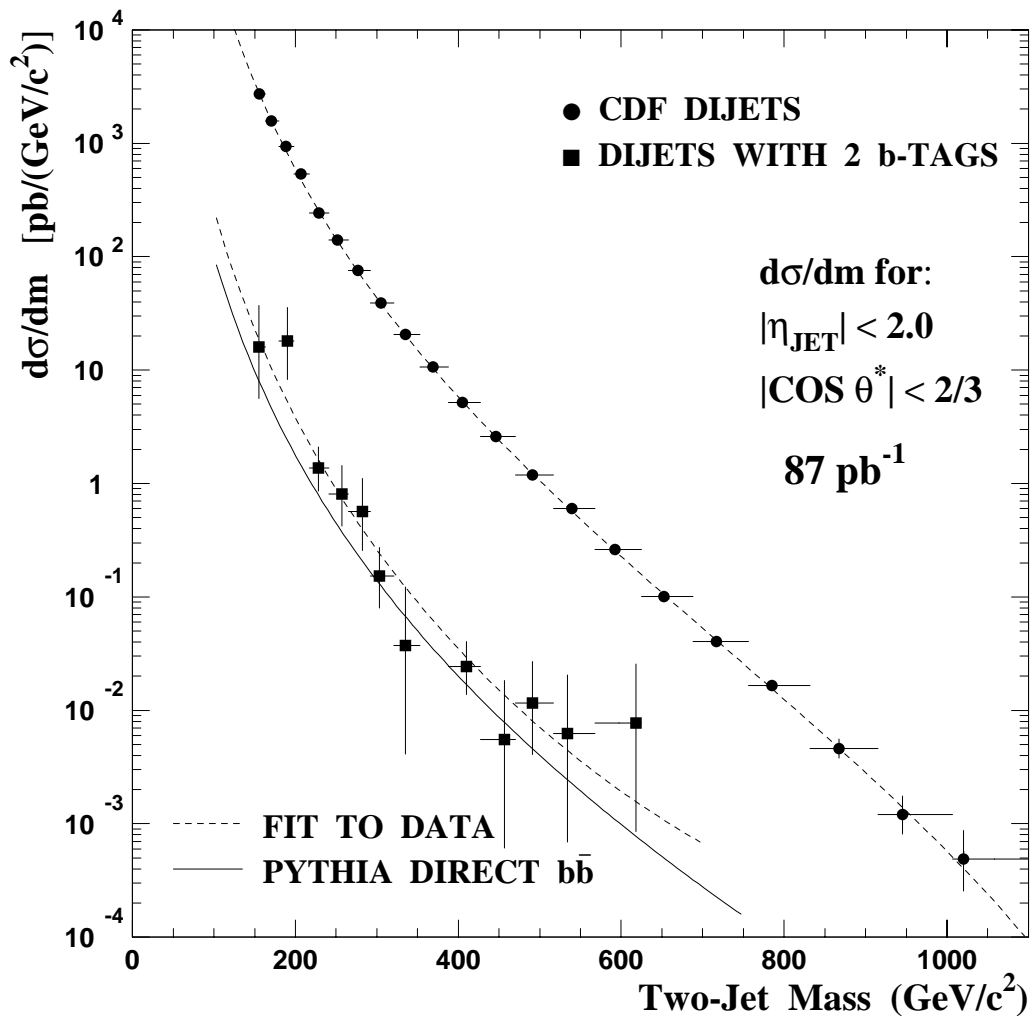
Physic study	background sample	$\frac{\text{Pythia Xsec}}{\text{Data Xsec}}$
$pp \rightarrow b\bar{b}\phi \rightarrow b\bar{b}b\bar{b}$ $pp \rightarrow VH \rightarrow b\bar{b}q\bar{q}$ $t\bar{t} \rightarrow b\bar{b}q\bar{q}q\bar{q}$	$4b\text{jet}+X$ $2b\text{jet}+2\text{jet}$ $2b\text{jet}+4\text{jet}$	30 how much? how much?

The World doesn't
know about this!!!

BUT!!

The diff. Xsec as a function of the two b-jet mass is well reproduced by Pythia!!!

hep-ex/9809022



Pythia & Herwig Simulation

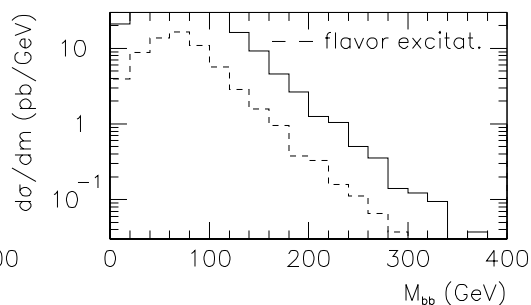
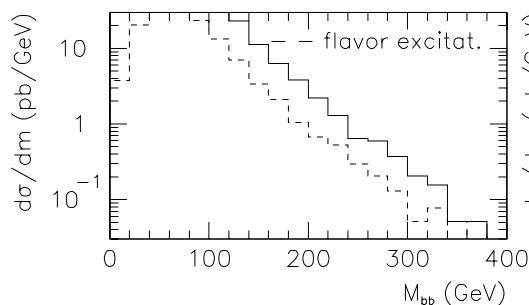
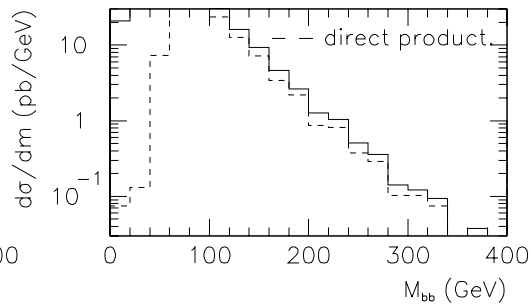
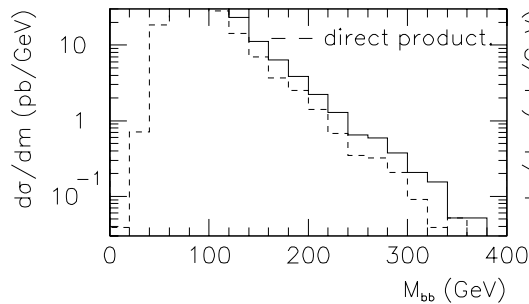
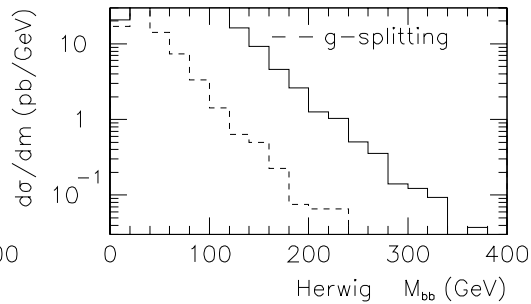
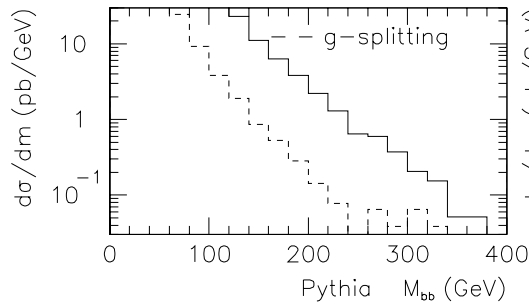
- Pythia v6.136
- Herwig v6.201
- CMSJET easy package to run
- $E_{CM} = 1800 \text{ GeV}$
- $P_{\text{t hat}} > 40 \text{ GeV}$
- $|\eta_{\text{parton}}| < 4$
- $|\eta_{\text{b jet}}| < 2$
- $R_{\text{cone}} = 0.6$
- seed $E_T = 5 \text{ GeV}$
- min Tower $E_T = 1 \text{ GeV}$

2b-jet : Pythia & Herwig

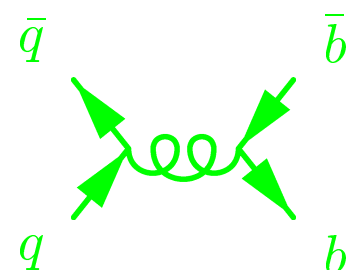
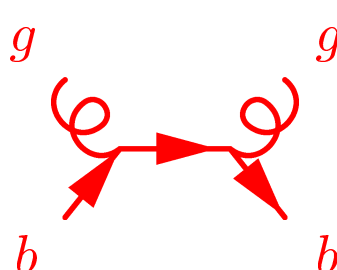
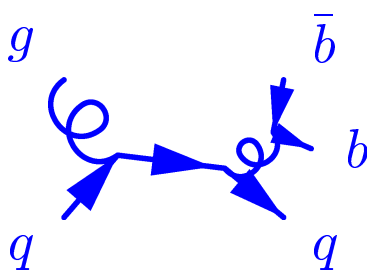
Direct production is dominant

Pythia

Herwig



Flavor excitation



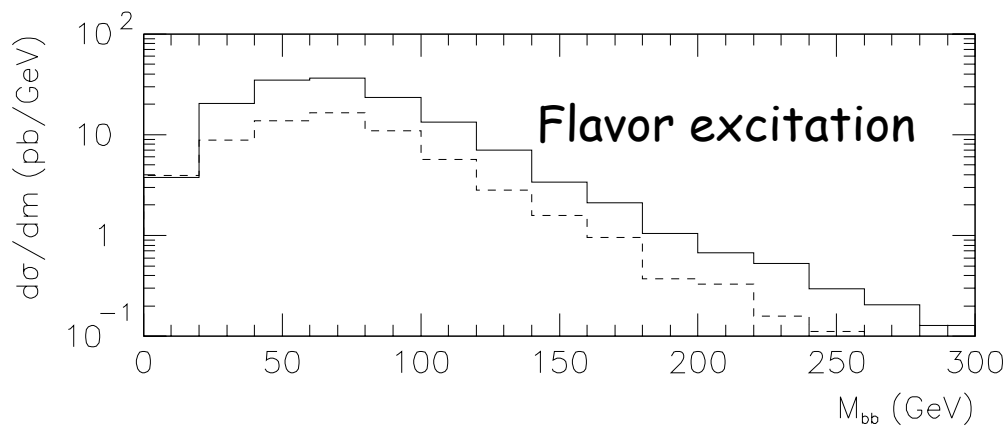
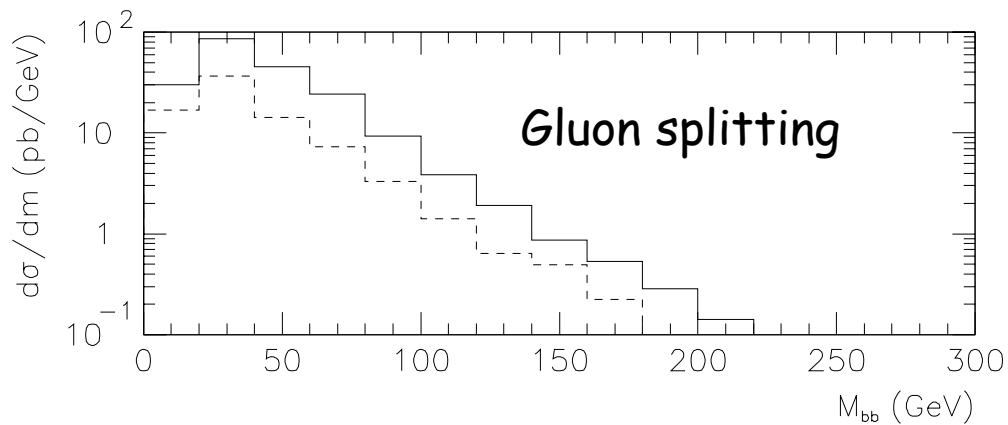
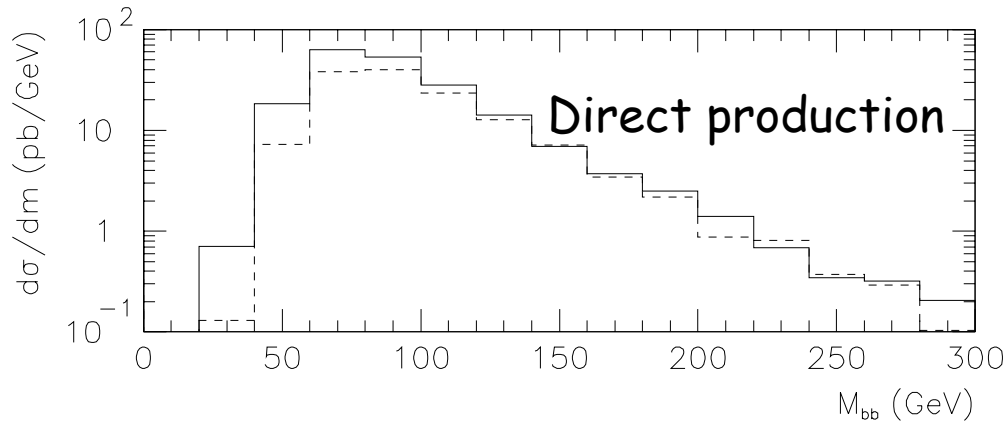
Gluon splitting

Direct production

2b-jet : Pythia & Herwig

Pythia ———

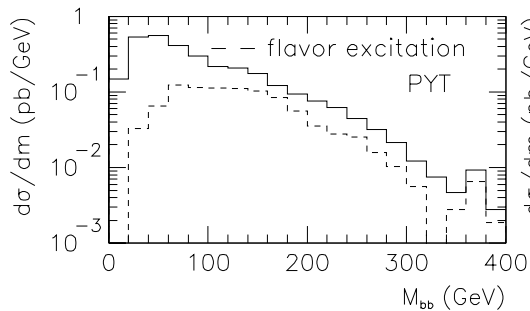
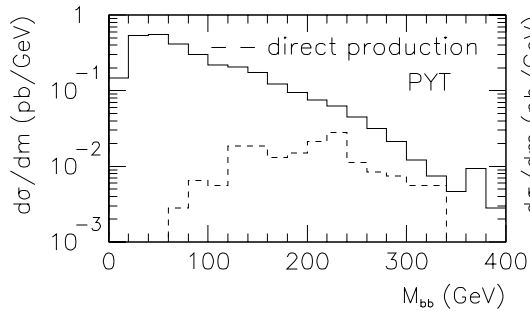
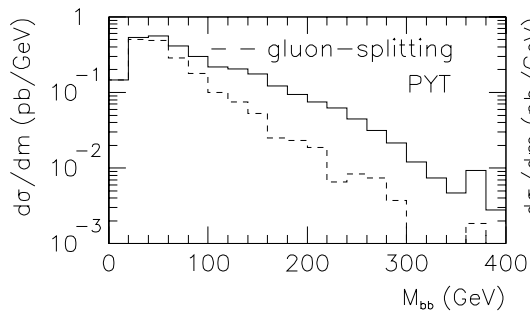
Herwig - - - -



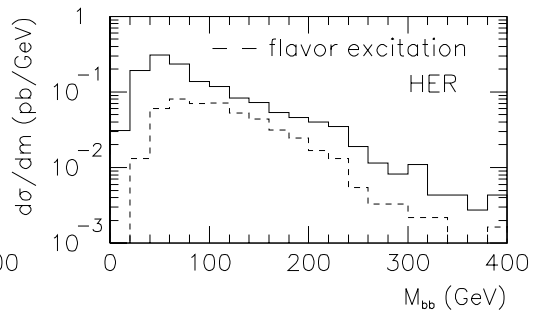
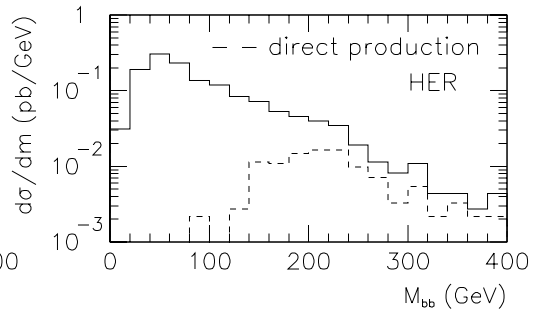
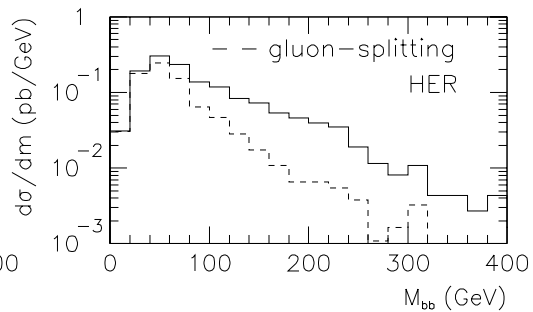
4jet of which 2b-jet $\Sigma P^T > 250$ GeV: Pythia & Herwig

Direct production is less important

Pythia



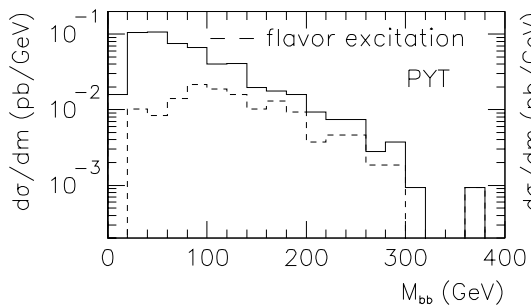
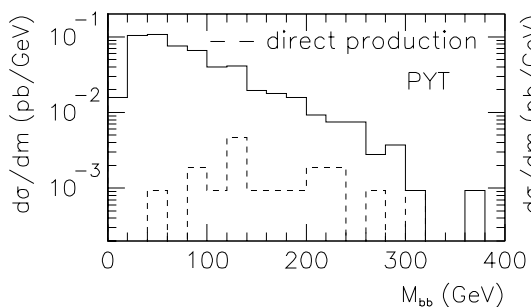
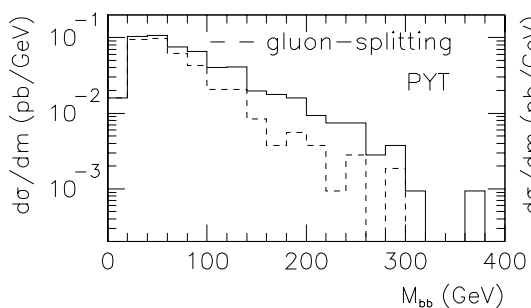
Herwig



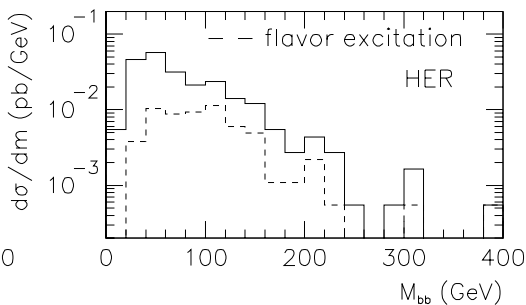
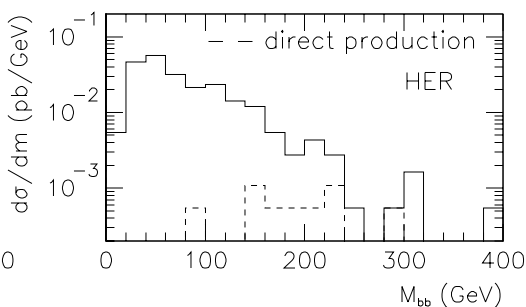
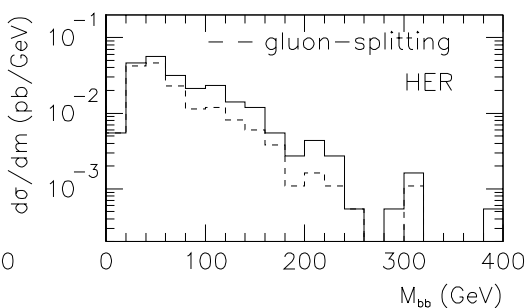
6jet of which 2b-jet $\Sigma P^T > 250$ GeV: Pythia & Herwig

Direct production is negligible

Pythia



Herwig



Independent Test of the Production Channels

- | | | |
|---------------------|-------|------------|
| • Direct production | • CDF | ok |
| | • LEP | ok |
| • Flavor excitation | • CDF | ? not ok ? |
| | • LEP | --- |
| • Gluon splitting | • CDF | ? not ok ? |
| | • LEP | not tested |

Init. State Rad. 75%
Fin. State Rad. 25%
Phys. Rev. D 50, 5562 (1994)



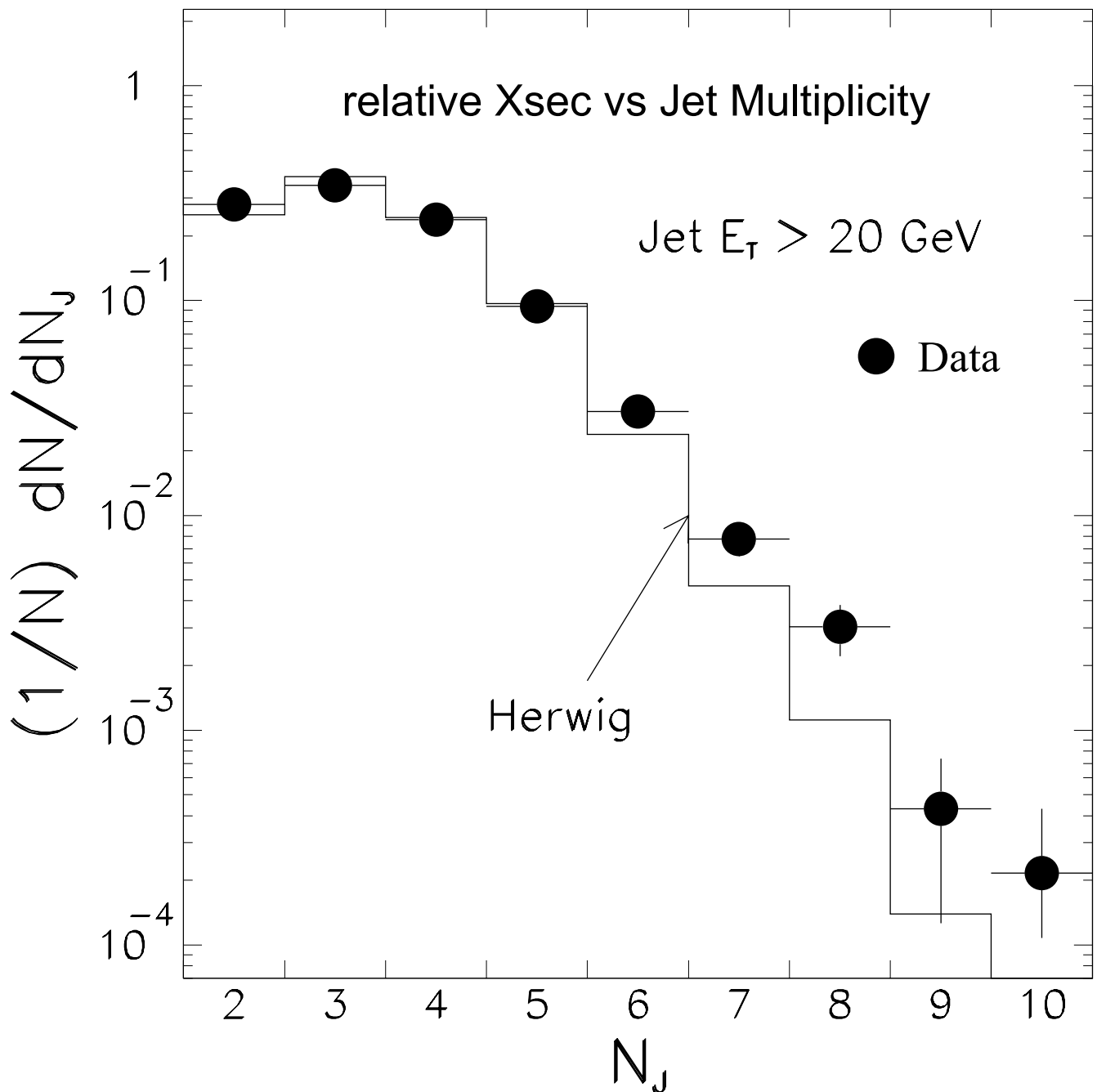
Run II

CDF?

D0?

QCD multijet without bs: only Herwig is studied and looks OK.

CDF Note 2443
Jan 1994



Conclusions

Shower Montecarlos have some problems reproducing multijet b Xsec. We need a specific paper.

Low jet multiplicity: well reproduced.
Direct production is the tested Mechanism.

High jet multiplicity: badly reproduced.
Flavor excitation and Gluon splitting are the main mechanisms.

Flavor excitation and Gluon splitting are **not** tested @ LEP.
The Tevatron should test them!